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TOWARDS TO LARGER CAPACITY OF EPS FOR CUBESAT: EXPERIENCE FROM STAR OF AOXIANG AND ISSUES FOR FUTURE DEVELOPMENT

Abstract

In recent few years the world has seen a dramatic increasing number of CubeSat missions, most of which have a volume ranging from 1U to 3U, and with a power consumption of only a few watts. As a highly critical component in CubeSat, electrical power system (EPS) is responsible for harvesting, converting and controlling the satellite's energy. Traditional EPS with a capacity of several or dozens of watts has already been unable of meeting the needs of many practical CubeSats with more complex functions and longer life. In some missions such as earth observation and deep space exploration, the power demand of CubeSat can reach hundreds of watts, which presents a new challenge to the application of traditional CubeSat power systems. Star of Aoxiang is the world's first 12U CubeSat with the objectives of earth atmosphere polarization modes detection and microgravity measurement built by Shaanxi Engineering Laboratory for Microsatellites (SELM) of NPU, China. It was launched by China's LM-7 vehicle on June 25, 2016. On-orbit telemetry data confirmed the design and functionality of the EPS in the satellite's 3-month lifetime. In this paper we analyze the power budgeting of the satellite, and present the design and implement of its EPS: MPPT based PV power converter, battery charge/discharge controller, multichannel DC-DC regulator, power distribution switches with protection, and monitoring circuitry based on a low-power MCU. Additionally, we discuss the results of ground experiments and on-orbit operation status of the EPS. The analysis presented is helpful to verify the functionality and reliability of the electrical power systems. To satisfy larger power demands of CubeSat in the near future, EPS with more power handling capacity is becoming an imperative requirement. Based on the experience gained from Star of Aoxiang, an advanced power system scheme is proposed with power handling capacity of hundreds of watts for CubeSats. The EPS scheme is featured by modularity, standardization, flexible of configuration, high efficiency, fault-tolerant, and use of Commercial off-the-shelf (COTS) components. The utility of standard modular multi-distributed converters is promising to maximize the power harvested from the optimized distributed deployable solar arrays. The designed EPS can provide a reliable and efficient solution to supply power to the subsystems of CubeSats. It will remain functioning properly in case that failure occurs in some parts of the solar arrays or power converters.